

REMARKS

Reconsideration of the application in view of the above amendments and the following remarks is requested. Claims 47-64 are in this application. Claims 1-46 have been cancelled. Claims 47-64 have been added to alternately claim the present invention.

The present divisional application was filed with copies of the 4 informal sheets of drawings that were originally filed in the parent application, along with 4 sheets of formal drawings. As a result, it is not clear which set of drawings (informal or formal) has been approved by the Examiner. Thus, applicant requests that 4 informal sheets and the 4 formal sheets of drawings filed with the divisional application be replaced with the 4 replacement sheets attached in Appendix A. The 4 sheets of replacement drawings are the same as the formal drawings filed with the divisional application.

The Examiner rejected claims 14-16, 33-37, and 39-42 under 35 U.S.C. §103(a) as being unpatentable over Tseng (U.S. Patent No. 5,741,741) in view of Inohara (U.S. Patent No. 5,976,972). The Examiner also rejected claims 18-19 and 43-45 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Inohara and further in view of Chittipeddi et al. (U.S. Patent No. 6,417,087).

The Examiner further rejected claim 20 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Inohara and further in view of Adams et al. (U.S. Patent No. 6,566,242). The Examiner additionally rejected claims 17 and 46 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Inohara and further in view of Yu et al. (U.S. Patent No. 5,952,704); or Tseng in view of Inohara in view of Chittipeddi et al. and further in view of Yu et al. (U.S. Patent No. 5,952,704). For the reasons set forth below, applicant respectfully traverses these rejections.

New claim 47 recites:

“forming a layer of insulation material over a semiconductor structure, the layer of insulation material having a top surface;

"performing a first etch of a first region of the top surface of the layer of insulation material without etching a second region of the top surface of the layer of insulation material, the first etch forming a plurality of openings in the layer of insulation material, the plurality of openings having depths and bottom surfaces; and

"simultaneously performing a second etch of the second region of the top surface of the layer of insulation material and the bottom surface of each opening, the second etch substantially increasing the depths of the openings to form a plurality of trenches, each trench having a bottom surface with a length that is significantly greater than a width."

The Tseng reference teaches a process that, as shown in FIGS. 1-3, begins by forming a number of trenches 13 in insulating layer 16. Applicant assumes the Examiner would read the formation of insulating layer 16 and the formation of trenches 13 shown in FIGS. 1-3 of Tseng to be the forming and performing a first etch elements required by claim 47. However, from what can be determined, there is nothing in Tseng or Inohara that teaches or suggests the simultaneously performing a second etch element required by claim 47.

With reference to Tseng, it is important to note that the trenches 13 formed in FIG. 3 are subsequently filled with metal to form a second layer of patterned metal traces. (See column 6, lines 8-9 of the Tseng reference.) After the trenches 13 have been etched, the trenches 13 are not immediately filled with metal to form the second layer of metal traces. This is because if the trenches were immediately filled with metal, then there would be no easy way to electrically connect the patterned metal traces in the second metal layer to the patterned metal traces 14 in the underlying first metal layer.

Instead, as shown in FIG. 6, Tseng teaches that a mask 24 is formed to cover and protect the trenches 13. Openings are then formed in mask 24 where T-shaped metal plugs (vias) are to be formed to make electrical connections to the patterned metal traces 14 in the underlying first metal layer. (See column 6, lines 53-58 of the Tseng reference.)

For example, the center trench 13 shown in FIG. 6 of Tseng is protected by mask 24 because, once the center trench is filled with metal to form a center

metal-2 trace, the circuit does not require an electrical connection (a metal plug or via) between the center metal-2 trace and the underlying metal-1 trace at that point. On the other hand, when the circuit requires electrical connections (metal plugs or vias) between metal traces in two metal layers, openings are formed in mask 24 (which are more precisely defined by hard mask 18). The openings are shown in cross section as the openings 13' in FIG. 6 of Tseng).

Thus, the etch step shown in FIG. 7 of Tseng only etches down to the patterned metal traces 14 in the underlying first metal layer where a via or metal plug is required to make an electrical connection between the metal traces in the first and second metal layers. As a result, when metal layer 30 is subsequently deposited in FIG. 9, the layer of metal fills up both the openings where a metal plug or via is to be formed, and the overlying trenches which form the patterned metal traces of the second metal layer.

Applicant, however, has been unable to find any discussion in Tseng that teaches or suggests that the metal plug or via openings are formed as trenches, which have bottom surfaces with lengths that are significantly greater than the widths as required by new claim 47. The Examiner acknowledges this in the discussion of the prior claims (see page 3, lines 20-21 of the July 2005 office action), but argues that FIGS. 9A-9B of the Inohara reference disclose metal plug or via openings that are formed as trenches.

FIGS. 9A-9B of Inohara, however, disclose the same basic concept as Tseng, i.e., the formation of a contact or via opening in the bottom surface of a trench (e.g., see FIG. 7 of Inohara). FIG. 9A of Inohara shows a wiring groove (trench) 46 and a contact hole 48 which has a length that is wider than the width of trench 46. Comparing FIGS. 9A-9B, by utilizing a contact hole 48 that has a length that is larger than the width of trench 46, a subsequently formed contact or via can be connected to the full width of trench 46 even if a lithographic misalignment occurs. (See column 3, lines 10-21 of Inohara.) Compare this to FIGS. 8A and 8B of Inohara

which shows that a misalignment can cause a significant reduction in the contacted surface area.

Applicant, however, can find nothing in the discussion of FIGS. 9A-9B of Inohara that teaches or suggests that the contact hole 48 is formed as a trench as required by new claim 47. The rectangular contact holes 48 shown in FIGS. 9A-9B of Inohara can not be read to be trenches because, although the length is greater than the width, the length is not significantly greater than the width as required by claim 47. Further, one skilled in the art would not be motivated to form the contact holes 48 as trenches because trench-sized contact holes 48 would severely limit how close together adjacent metal traces can be placed to each other.

Thus, there is nothing in Tseng and Inohara that can be read to be the simultaneously performing a second etch element of claim 47. As a result, new claim 47 is patentable over Tseng in view of Inohara. In addition, since claims 48-64 depend either directly or indirectly from claim 47, claims 48-64 are patentable over Tseng in view of Inohara for the same reasons as claim 47.

With respect to Chittipeddi, this reference teaches in FIGS. 1 and 2 a bond pad 27 with a number of vias 19 that are connected to a conductive film 5. However, as shown in the plan view of FIG. 3, none of the vias 19 are formed as trenches. Thus, there is nothing in Chittipeddi that can be read to be the simultaneously performing a second etch element required by claim 47.

As a result, new claim 47 is patentable over Tseng in view of Inohara and further in view of Chittipeddi. In addition, since claims 48-64 depend either directly or indirectly from claim 47, claims 48-64 are patentable over Tseng in view of Inohara and further in view of Chittipeddi for the same reasons as claim 47.

With respect to Adams, the Examiner cited this reference as teaching a barrier layer, seed layer, and copper layer. Applicant, however, has been unable to find any discussion in Adams that teaches or suggests forming contact or via openings as trenches as required by claim 47. As a result, claim 47 is patentable over Tseng in view of Inohara and further in view of Adams. In addition, since claims 48-64

depend either directly or indirectly from claim 47, claims 48-64 are patentable over Tseng in view of Inohara and further in view of Adams for the same reasons as claim 47.

With respect to Yu, the Examiner cited this reference as teaching loops in the same plane. Applicant, however, has been unable to find any discussion in Yu that teaches or suggests forming contact or via openings as trenches as required by claim 47. As a result, claim 47 is patentable over Tseng in view of Inohara and further in view of Yu; and Tseng in view of Inohara in view of Chittipeddi et al. and further in view of Yu. In addition, since claims 48-64 depend either directly or indirectly from claim 47, claims 48-64 are patentable over Tseng in view of Inohara and further in view of Yu; and Tseng in view of Inohara in view of Chittipeddi et al. and further in view of Yu for the same reasons as claim 47.

Thus, for the foregoing reasons, it is submitted that all of the claims are in a condition for allowance. Therefore, the Examiner's early re-examination and reconsideration are requested.

Respectfully submitted,

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APPENDIX A

AMENDMENT IN RESPONSE TO OFFICE  
ACTION MAILED JULY 27, 2005

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